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Final Report
to

Air Force Office of Scientific Research
Contract AF 49 (638)-801

Quantum Field Theory and Elementary Particles

January 1, 1960 - August 31, 1962

Submitted by

A.O. Barut
Project Director

The nature and the results of the research carried on during the past 33 months under the above contract can best be seen from the list of publications attached. We shall briefly stress the more important results:

(1) Our ideas about the role of resonances in strong interactions and dispersion relations, expressed in the original proposal have proved to be correct and contributed to the understanding of resonances in strong interactions. (Papers 3,8,9,11 and 2).

(2) The S Matrix Theory has been formulated in an invariant fashion which made it possible to treat scattering of particles with arbitrary spins and isospins and their analytical continuation uniformly (Papers 16, 24)

(3) The recent hypothesis about the complex angular momentum poles (the so called Regge poles) of the relativistic S Matrix has been investigated and properties of these poles determined. Complex Angular Momentum has been extended to the scattering of particles with arbitrary spins. (Papers 10, 17, 20, 21, 24)

(4) The two components higher order spinor equations have been quantized for the first time predicting 'neutrinos' for each fermian (Papers 18 and 19).

Other research include the investigation of strange particles and hyperfragments (Papers 7, 12, 13, 14, 15, 22, 23, 25) and work on electrodynamics and weak interactions (1, 4, 5, 6)

During the period of the contract three graduate students have received their Ph.D. They are George Mullen, Keiser Ruei and William Zeleny. Two others, E. Branscomb and J. Dilley, are working towards Ph.D. Two research associates Dr. S. Iwao and Dr. B. Unal have worked on the project. During the last part of the contract we had the opportunity to work in close collaboration with many physicists at Berkeley, California, which has been very valuable.

List of Publications: January 1, 1960 - August 31, 1962

1. A. O. Barut and C. Fronsdal, Spin-Orbit Correlations in μ - e and e^- - e^- Scattering, Phys. Rev. 120, 1871 (1960).
2. A. O. Barut and K. H. Ruei, Analytical Properties of the S Matrix and Uniqueness of Scattering Potential, J Math. and Phys., 2, 181 (1961).
3. A. O. Barut and K. H. Ruei, Extra Solutions of the Dispersion Relations and Resonance Scattering, Nuclear Phys. 21, 300 (1960).
4. A. O. Barut and W. B. Zeleny. Baron Currents in the Theory of Weak Interactions, Phys. Rev. 121, 908 (1961).
5. A. O Barut and M. Laiser, Note on gauge Transformations in Quantum Mechanics, Am. J Phys 29, 24 (1961).
6. A. O Barut and M. Samiullah, The Kemmer β - Formalism for Particles of Spin One-Half, Nuovo cimento 17, 876 (1960).
7. S. Iwao, Double Hyperfragments and Relative Parity of Λ and Σ Hyperons. Nuclear Phys. 26, 1 (1961)
8. A. O. Barut and K. H. Ruei, Kinematical and Dynamical Resonances, Phys. Rev. 122, 1340 (1961).
9. A. O. Barut and K. H. Ruei, Nature of the Resonance in p - wave Meson Nucleon Scattering in One-Meson Approximation, Nuclear Phys. 30, 462 (1962)
10. A. O. Barut, Virtual Particles, Phys. Rev. 127, 321 (1962).
11. A. O. Barut, Dispersion Relations and Resonances Scattering, Chapter in Lectures in Theoretical Physics, Edit. by W. E Brittin, Vol. IV, Interscience Publishers, 1962.
12. S. Iwao and J. Leitner, The Pion Spectrum in Radiative Hyperon Decay, Nuovo cimento 22, 904 (1961).
13. S. Iwao, On the Interaction of the Pion and Cascade Particle, Prog. Theor. Phys. 26, 1008 (1961).

14. S. Iwao, Preliminary Determination of Σ-Λ Parity using Polology, Nuovo cimento 23, 516 (1962).

15. S. Iwao, A Comment on the Σ-Λ Parity and Resolution between the Bound State Model and the Isobar Model of Y_1^*, Nuovo cimento, 23, 784 (1962).

16. A. O. Barut, Formulation of the S - Matrix Theory in Terms of the Representations of the Inhomogeneous Lorentz group. Phys. Rev. (July 1, 1962). Enlarged version in H. P. Stapps, Lectures in S Matrix Theory, W. A. Benjamin, Inc. N. Y. 1962.

17. A. O. Barut and D. E. Zwanziger, Complex Angular Momentum in Relativistic S. Matrix Theory, Phys. Rev. (Aug. 1, 1962).

18. A. O. Barut and G. Mullen, Quantization of two component Higher Order Spinor Equations, Ann Phys. (in press)

19. A. O. Barut and G. Mullen, Action Principle for Higher Order Lagrangians with an Indefinite Metric, Ann. Phys. (in press).

20. A. O. Barut and F. Calogero, Singularities of the Scattering Amplitude in Complex Angular Momentum for a Class of Soluble Potentials. Phys. Rev. (in press)

21. A. O. Barut, Analyticity in Angular Momentum of the Relativistic Many Channel S Matrix from Dispersion Relation and Unitarity. Phys. Rev. (in press).

22. S. Iwao, A Theory of Hyperfragments III, Nuovo cimento (in press).

23. S. Iwao, $\bar{K}$ - N Scattering in the Mandelstam Representation, Nuovo cimento (in press).

24. A. O. Barut, I. Muzinch and D. Williams, Construction of Invariant Scattering Amplitudes for Arbitrary Spins and Analytical Continuation in Total Angular Momentum, Phys. Rev. (to be published).

25. S. Iwao, Beta Decay of Neutral Kaon (to be published)

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